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EXAMINER	
WANG, EUGENIA	

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Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

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Office Action Summary	**Application No.** 10/685,346	**Applicant(s)** MATHIAS ET AL.	
	Examiner Eugenia Wang	**Art Unit** 1745	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *10/14/2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *2-31,35-41,43-45 and 48-57* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *2-31,35-41,43-45 and 48-57* is/are rejected.

7)☒ Claim(s) *3-31, 35-41, 43-45, 47, 55, 56* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *14 October 2003* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *1/12/04, 5/10/04*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Priority

1. The disclosure is objected to because of the following informalities: the status of application10/345,121 is incorrect and should be updated to the current status of abandoned. The status of the other claimed priority applications should also be updated to reflect their current status. Appropriate correction is required.

Drawings

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: (1) while referring to figures 2 and 4 collectively, parts 21 and 23 are mentioned but those parts are not included with figure 4; (2) while talking about figure 3, part 21 is mentioned but not illustrated with the figure; (3) will referring to figures 2 and 3 collectively parts 20 and 23 are mentioned but the specified parts are not included with figure 3. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either “Replacement Sheet” or “New Sheet” pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of

any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

3. Claim 3 is objected to because of the following informalities: claim 3, dependant on claim 55, uses "said non-perfluorinated polymers, said metal oxides" in line 2, however non-perfluorinated polymers and metal oxides were first mentioned in claim 2. Mislabeling the dependency of claim 3 is assumed, and the rest of the Office Action reflects the claim as if it were dependant on claim 2 rather than claim 55. Appropriate correction is required.

4. Claim 41 is objected to because of the following informalities: dependant claim 41 is included within independent claim 55. Therefore, claim 41 is dealt with within the independent claim 55, rather than by itself. Appropriate correction is required.

5. Claims 43 and 44 are objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Paragraph 8 in the detailed description section of the specification defines high and low density regions [26] and [28], respectively. Hydrophilic property is linked to [26] in paragraph 12, where the high density region is described as sufficiently hydrophilic to define contact angles. If hydrophilicity is linked to the high density regions [26], then hydrophobicity is linked to the low density regions [28]. Therefore the first face, which is more hydrophilic (as

stated by claim 55), would be characterized as having high particle density regions of relatively large cross section dimensions (as stated in claim 43). Consequently, the second major face would be characterized as having high particle density regions of relatively small cross sectional dimensions. Since claim 43 is not further limiting, claim 44 is not further limiting, because it is embodied within independent claim 55.

6. Claim 45 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. Paragraph 8 in the detailed description section of the specification defines high and low density regions [26] and [28], respectively. Hydrophilicity is linked to [26] in paragraph 12, where the high density region is described as sufficiently hydrophilic to define contact angles. If hydrophilicity is linked to the high density regions [26], then hydrophobicity is linked to the low density regions [28]. Therefore the first face, which is more hydrophilic (as stated by claim 55) would also be characterized as being dominated by high particle density regions, leaving the second face dominated by low particle density regions. However, claim 45 says that the relatively high and relatively low particle density regions vary such that one face is dominated by the relatively high density regions, while the other is dominated by the relatively low particle density regions. This does not further limit claim 55, because it is broader, since claim 55 specifies which face is hydrophobic (linked to low particle density region) and which face is hydrophilic (linked to high particle density region).

7. Claim 47 is objected to because of the following informalities: dependant claim 47 is included within independent claim 57. Therefore, claim 47 is dealt with within the independent claim 57, rather than by itself. All claims dependant on claim 47 are treated as if dependant on the independent claim that includes it. Appropriate correction is required.

8. Claims 2-31, 35-41, 55 and 56 are objected to because of the following informalities: claim 55, line 12 talks about material disposed along "one of said first and second major faces." However, the alternative 'or' should have been used instead of "and." Claims 2-31, 35-41, and 56, dependant on claim 55, do not remedy the objection and are objected to for the same reason. Appropriate correction is required.

Claim Rejections - 35 USC § 112

9. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

10. Claims 9 and 17-23 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

11. In claim 9, the water transfer particles are referred to as "unbound dust," which is indefinite because once dust is put into a porous matrix, it is then bound within the matrix. This claim is not further dealt with in the office action.

12. Claims 17 and 18 refer to "characteristic density value," which is unclear and thus indefinite. Since claim 19 is dependant on claim 18, it is also rejected. These claims are not further dealt with in the office action.

13. Claim 18 recites the limitation "the next" in line 3. There is insufficient antecedent basis for this limitation in the claim.

14. Claims 20-23 use the terms “advancing contact angle” (claims 20 and 21) and “receding contact angle” (claims 22 and 23) are not defined or differentiated in a clear manner and thus are indefinite.

15. Where applicant acts as his or her own lexicographer to specifically define a term of a claim contrary to its ordinary meaning, the written description must clearly redefine the claim term and set forth the uncommon definition so as to put one reasonably skilled in the art on notice that the applicant intended to so redefine that claim term. *Process Control Corp. v. HydReclaim Corp.*, 190 F.3d 1350, 1357, 52 USPQ2d 1029, 1033 (Fed. Cir. 1999). The term “contact angle” in claims 20-23 is used by the claim to mean “the exterior angle between the liquid and the solid”, while the accepted meaning is “interior angle between the liquid and the solid.” This is evidenced by “Contact angle from Wikipedia” and U.S. Patent 6350539 (Wood, III, et al.). The term is indefinite because the specification does not clearly redefine the term.

Claim Rejections - 35 USC § 103

16. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

17. Claims 4-8, 10-13, 28, 29, 36, 37, 55, and 56 are rejected under 35 U.S.C. 03(a) as being unpatentable over U.S. Patent 6024848 (Dufner et al.).

18. As to claim 55, Dufner et al. teaches bi-layer, porous support plates [40,42] (column 3, lines 53-55). The purpose of the plates is to enhance the transport of fluids throughout the cell (column 4, lines 21-22). Figure 2 shows the plates, which clearly define a major planar dimension, with two major faces running parallel to the planar dimension ([44, 48] and [46, 50]). In one bi-layer (contact layer) of Dufner et al.'s support plate is a mixture of hydrophobic and hydrophilic materials, which creates integrated but discrete regions (column 8, lines 2-8). The other layer (substrate layer) is made of a plurality of hydrophobic [54 A-E, 58 A-E] and hydrophilic [52 A-E 56 A-E] sections, which is shown to alternate across the major planar dimension of the porous plate. It is important to note the connection between hydrophilicity and density of water transfer particles. Dufner et al. teaches that the hydrophilic phase facilitates transfer of liquid (column 4, lines 8-13). Therefore, a high density of water transfer particles corresponds to a hydrophilic nature, while a low density of water transfer particles corresponds to a hydrophobic nature. Dufner et al. does not disclose disposing a layer of hydrophobic material along one of the major faces of the diffusion media. However, according to Dufner et al., it is known to treat support layers with hydrophobic substances, since it facilitates transport of gaseous reactants, reducing product fluids, while water moves through the support layer as vapor. Additionally, it minimizes the excess accumulation of liquid water at the cathode thereby restricting access to the gaseous oxidant to the cathode electrode (column 2, lines 54-61). In an alternate

interpretation, the substrate bi-layer can be seen as the diffusion media, while the contact bi-layer, which contains hydrophobic material used to facilitate gas transfer and restrict liquid water absorption, can be seen to carry out the same function. It would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate hydrophobic material disposed along one of the major faces of the diffusion media since it was known in the art that a diffusion layer is typically a porous material that is often coated on one edge with a hydrophobic material in order to promote water rejection.

19. Regarding claim 4, the teachings of Dufner et al. are set forth above. Dufner et al. additionally teaches the use of a hydrophilic compound having carbon black dispersed mixed with a proton exchange resin, such as polyflourosulofonic ionomer (column 9, lines 28-34). Since an ionomer is a polymer, the mixture is a carbon/polymer composite.

20. With regards to claim 5, the teachings of Dufner et al. are set forth above. Dufner et al. additionally teaches the use of carbon black in the hydrophilic material (column 6, lines 37-39). Dufner et al. continues to define carbon black as including graphitized carbon black (column 6, lines 41-42).

21. Regarding claim 6, the teachings of Dufner et al. are set forth above. Additionally, Dufner et al. teaches plates that include hydrophilic areas, which appear in a mixed form [44, 48] or in discrete form [46, 50]. Each hydrophilic area is forms the porous matrix it comprises of (column 6, lines 24-32; column 7, lines 54-55).

22. Regarding claim 7, the teachings of Dufner et al. are set forth above. Dufner et al. further teaches that the hydrophilic areas include carbon. Carbon black is an addition to the hydrophilic material [44, 48], while the discrete hydrophilic areas may be a carbon-carbon fibrous composite [46, 50] (column 6, lines 37-40; column 7, lines 54-55). Dufner et al. discloses the claimed invention except for that the porous matrix comprises of specifically carbon paper. However carbon and carbon fibbers can be used to make a paper form of carbon. It would have been obvious to one having ordinary skill in the art at the time the invention was made to allow the diffusing support plate to be comprised of carbon paper, since it was known in the art that a carbon paper is a typical material used to make a gas diffusion layer.

23. As to claim 8, the teachings of Dufner et al. are set forth above. Dufner et al. further teaches that carbon black is used in the hydrophobic regions of the porous support plates (column 6, lines 35-36).

24. Regarding claim 10, the teachings of Dufner et al. are set forth above. Dufner et al.'s support plates show sections where the hydrophilic sections are distributed across a cross section of the porous diffusion media between the first and second major faces of the diffusion area, as is seen in the bi-layers denoted by [46, 50].

25. As to claim 11, the teachings of Dufner et al. are set forth above. Furthermore, Dufner et al. teaches a porous support plate where the high and low particle density regions alternate across at least one of said first and second major faces of said diffusion media, as show in the [46, 50] by the alternating hydrophobic and hydrophilic regions [54 A-E, 58 A-E] and [52 A-E, 56 A-E], respectively.

26. Regarding claim 12, the teachings of Dufner et al. are set forth above. Dufner et al. does not teach the period of the alternating density regions. However, the period of the alternating density regions is a result effective variable. Having larger periods would more easily facilitate water transfer with respect to the period, while having smaller periods would provide a more evenly distributed transfer of both gas reactants and the liquid product. Discovery of optimum of result effective variable in known process is ordinarily within the skill of art. (In re Boesch, 205 USPQ 215 (CCPA 1980).) Selection of optimum ranges within the prior art's general condition is obvious. (In re Aller, 105 USPQ 233(CCPA 1955))

27. Regarding claim 13, the teachings of Dufner et al. are set forth above. Dufner et al. does not specifically disclose a diffusion media where the high and low particle regions alternate across both major faces of the media. It would have been obvious to one having ordinary skill in the art at the time the invention was made that the alternating section of the bi-layer [46, 50] could have been duplicated to replace the contact bi-layer [44,48], since it has been held that mere duplication of the essential working parts of a device involves only routine skill in the art. *St. Regis Paper Co. v. Bemis Co.,* 193 USPQ 8. In an alternate view, one could view sections [46, 50] as its own diffusion media, which would fulfill the stipulation of having high and low particle density regions alternating across both faces of the media, whose faces are denoted by [46,50].

28. As to claims 28 and 29, the teachings of Dufner et al. are set forth above. Dufner does not teach a porous matrix defined by a permeometer number, more specifically a

Gurley permeometer number. Permeometer numbers, however, characterize porosity by measuring the time it takes for a certain volume of air to flow through a cross section (area) of a sample at a certain pressure. Because porosity provides both surface area contact as well as spaces for facile flow throughout the matrix, porosity can be labeled a result effective variable. It can be optimized with respect to fluid transfer performance. Discovery of optimum of result effective variable in known process is ordinarily within the skill of art. (In re Boesch, 205 USPQ 215 (CCPA 1980).) Selection of optimum ranges within the prior art's general condition is obvious. (In re Aller, 105 USPQ 233(CCPA 1955))

29. Regarding claim 36, the teachings of Dufner et al. are set forth above. As previously mentioned, the layer of hydrophobic material is considered common knowledge; therefore a specific loading on the diffusion surface is not specified. However, the loading is a result effective variable. Its dispersion within the diffusion matrix affects porosity at that surface. Porosity is a balance between surface area contact as well as spaces for facile flow throughout a porous matrix. Thus, porosity can be optimized with respect to performance of the matrix (ie fluid transfer). Discovery of optimum of result effective variable in known process is ordinarily within the skill of art. (In re Boesch, 205 USPQ 215 (CCPA 1980).) Selection of optimum ranges within the prior art's general condition is obvious. (In re Aller, 105 USPQ 233(CCPA 1955))

30. As to claim 37, the teachings of Dufner et al. are set forth above. The layer of hydrophobic material is assumed to be common knowledge. Although the degree of hydrophobicity between the layer and the relatively high and low particle density of the

diffusion media is not stated, it is obvious that the hydrophobic layer should be more water repellant than the porous diffusion media. The porous diffusion media with water transport particles has the purpose of transferring water across the membrane using the water transfer particles. If the high or low density areas of the diffusion media were more water repellent, the water would rather stay at the hydrophobic layer, thus defeating the purpose of the invention.

31. As to claim 56, the teachings of Dufner et al. are set forth above. However, Dufner et al. does not teach the fact that the water transfer particles have dimensions small enough to migrate through the dimensions of the porous matrix. However, it is obvious that if a particle is small enough to fit into a porous matrix, that it would be small enough to move within that matrix.

32. Claims 24, 25, 30, 31, 38-40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dufner et al. in view of EP 08272907A1 (Taniguchi et al.).

33. Regarding claim 24, the teachings of Dufner et al. are set forth above. However, Dufner et al. does not teach the porosity of the hydrophobic and hydrophilic materials used. Taniguchi et al. teaches a current collector made of a porous substrate, which hydrophilic and hydrophobic bulking agents, R1 and R2, respectively, are distributed into (column 5, lines 56-58; column 6, lines 1-5). The purpose of the inclusion of these materials is for fluid transfer. Water is transferred through the hydrophobic areas, while the hydrophilic areas provide areas for gas permeability (column 2, lines 43-44; column 3, lines (column 3, lines 8-12). Furthermore the size of the particles used for the bulking materials depend on the porous substrate (column 8, lines 34-35). However, the agents

are loaded such that the bulk density lies between 0.12 g/cm^3 to 0.15 g/cm^3 (column 8, lines 40-42). The range is relatively small, thus assuring a substantially uniform porosity profile across the major planar dimension. Both Dufner et al. and Taniguchi et al. teach plates used for diffusion purposes that have mixed hydrophobic and hydrophilic materials. Additionally, the materials used are all similar (or in some cases the same). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made that the general uniformity of porosity would be similar as well.

34. Regarding claim 25, the teachings of Dufner et al. are set forth above. Dufner et al. does not specifically disclose which electrically conductive material is used to make a porous matrix of a diffusion media. However, Taniguchi et al. teaches a porous substrate made of carbon fibers (column 5, lines 56-58). These carbon fibers can be used to make carbon papers and cloths. The other listed materials all have the same electrically conductive property, so it would have been obvious to one having ordinary skill in the art at the time the invention was made to make the plate out of carbon paper, graphite paper, cloth felt, foam, carbon or graphite wovens, carbon or graphite non-wovens, metallic screens or foams, and combinations thereof, since all of the materials have a similar desired property.

35. As to claims 30 and 31, the teachings of Dufner et al. are set forth above. Dufner et al. does not teach the use of agents used for bindings. However, Taniguchi et al. teaches bulking materials; the hydrophilic bulking phase (R2) is used to bind the hydrophilic phase (R1) to the porous substrate (column 7, lines 29-32). Examples of the binders that are given are polymeric flouroresins: polytetrafluoroethylene (Teflon,

PTFE), tetrafluoroethylene-perfluoroalkylvinylethercopolymer (PFA), tetrafluoroethylene-hexafluoropropylenecopoplymer (FEP), polychlorotrifluoroethylene (PCTFE), polyvinylidene fluoride (PVDF), polyvinyl fluoride (PV), and tetrafluoroethylene-ethylenecopolymer (ETFE) (column 7, lines 19-32). Both prior arts teach inventions that are used for fluid diffusion, so it would have been obvious to one having ordinary skill in the art at the time the invention was made to combine Taniguichi et al.'s idea of further binding the hydrophilic material to the diffusion plate that Dufner et al. teaches.

36. Regarding claims 38-40, the teachings of Dufner et al. are set forth above. The layer of hydrophobic material is assumed to be common knowledge. Dufner et al. does teach hydrophobic materials which include a mixture of high structure carbon black and a hydrophobic polymer (column 6, lines 52-55). The example of a hydrophobic polymer given is fluorinated ethylene propylene (FEP-120) (column 7, lines 6-8). Although Dufner et al. does not mention any further examples of fluoropolymers, Taniguchi et al. teaches many used for hydrophobic bulking material purposes. Some examples given include PTFE, ETFE, PVDF, among others (column 7, lines 19-32). Although not all of the examples of the hydrophobic materials are listed in when combining Dufner et al. and Taniguchi et al., some of the listed materials are covered, and the unmentioned ones have similar properties as the ones covered by the prior arts. It would have been obvious to one having ordinary skill in the art at the time the invention was made to be aware of common materials used for hydrophobic purposes and apply that to any device in the art requiring the property.

37. Claims 2, 3, 14-16, 20-23, 26, 27, 35, 43-45, 48-53, 57 are rejected under 35 U.S.C. 103(a) as being unpatentable over Dufner et al. in view of Wood, III et al.

38. Regarding claims 2 and 3, the teachings of Dufner et al. are set forth above. Dufner et al. further discusses the use of carbon black including graphitized carbon black in the hydrophilic phase of the contact bi-layer (column 6, lines 36-40). It also teaches wettability improvement of the discrete hydrophilic region if it is treated with certain compounds. The list given - aluminum oxide, silicon oxide, and tin oxide – are all metal oxides (column 8, lines 28-34). Dufner et al. does not teach a non-perfluorinated polymer, namely polyvinylidine fluoride, that can be used as water transfer particles. Wood, III et al. teaches a diffusion structure comprising an absorption layer, a bulk layer, and a desorption layer with increasing hydrophobic (column 2, lines 32, 52). Additionally, Wood, III et al. teaches that the adsorption layer, the most hydrophilic layer, comprises of an electrically conductive material dispersed in a support binder (column 8, lines 18-24). Examples given include polyvinylidine fluoride (PVDF), polyvinyl alcohols, polystyrenes, organic silicates, aliphatic silanes, or any other polymer or organic material having the desired properties (column 8, lines 30-34). Since both inventions are diffusion plates, it would have been obvious to one having ordinary skill in the art at the time the invention was made to use known materials to bring out specific properties, in this case hydrophobicity.

39. As to claims 14-16, the teachings of Dufner et al. are set forth above. However, neither teaches a diffusion media where a cross sectional dimension of the relatively high and relatively low particle density regions vary inversely across the diffusion plate

or a cross section of the diffusion media in such away that one face is more hydrophobic, while the other is more hydrophilic. Wood, III et al. teaches a multilayer diffusion structure with three layers, an absorption layer, a bulk layer, and a desorption layer with increasing hydrophobicity (column 7, lines 32-41). In this embodiment of a diffusion medium, an inverse relationship exists, as one face starts out with a high density of water transfer (hydrophilic) particles. This property lessens as one moves across the diffusion media. The purpose of this assembly is to disperse reacting gases as well as to remove reaction products (namely water) (column 4, lines 15-19). Because the diffusion plates serve the same purpose, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate the inverse relationship of Wood, III et al. to the diffusion plate expressed by Dufner et al.

40. As to claims 20-23, the teachings of Dufner et al. and are set forth above. Dufner et al and Taniguchi et al. do not mention contact angles with respect to hydrophilicity. As previously mentioned, "Contact angle from Wikipedia" as well as Wood, III et al. define the contact angle as the interior angle between the liquid droplet and the solid interface. Moreover, Wood, III et al. define hydrophilic materials to have a contact of less than 90° (column 7, lines 47-48). Since the claim language uses contact angle differently, the numbers that are needed for comparison purposes are: (180°- angle). The redefinition of contact angle in terms of the given claim now means that hydrophilic materials have a contact angle of more than 90°. All ranges given for the advancing and receding contact angles fit within this definition of hydrophilicity. Overlapping ranges are *prima facie* evidence of obviousness. It would have been obvious to one

having ordinary skill in the art to have selected the portion of Wood, III et al.'s range that corresponds to the claimed range. *In re Malagari*, 182 USPQ 549 (CCPA 1974).

41. Regarding claims 26 and 27, the teachings of Dufner et al. are set forth above. Dufner et al. does not specifically teach the thickness of the diffusion plate. Wood, III et al. teaches a diffusion structure that has a thickness range between 160 μm and 1300 μm for its uncompressed, preassembled state (column 7, lines 65-67; column 8, lines 1-2). Most of the range for the claimed thickness falls under Wood, III et al.'s specified range, namely the size defined by claim 27. It has been held that when the difference between a claimed invention and the prior art is the range or value of a particular variable, then a prima facie rejection is properly established when the difference in the range or value is minor. Titanium Metals Corp. of Am. v. Banner, 778 F.2d 775, 783, 227 USPQ 773, 779 (Fed. Cir. 1985).

42. Regarding claim 35, the teachings of Dufner et al. are set forth above. Neither specifically teaches a hydrophobic layer and a thickness. Wood, III et al. does teach a diffusion plate which includes desorpbtion (hydrophobic) layer (column 7, lines 39-40). Wood, III et al.'s desorption layer is given a thickness range for the uncompressed material: 40 μm to 400 μm (column 8, lines 1-2). The claimed thickness (up to 125 μm) falls within this range. Overlapping ranges are *prima facie* evidence of obviousness. It would have been obvious to one having ordinary skill in the art to have selected the portion of Wood, III et al.'s range that corresponds to the claimed range. *In re Malagari*, 182 USPQ 549 (CCPA 1974).

43. As to claim 57, Dufner et al. teaches bi-layer, porous support plates [40,42] (column 3, lines 53-55). The purpose of the plates is to enhance the transport of fluids throughout the cell (column 4, lines 21-22). Figure 2 shows the plates, which clearly define a major planar dimension, with two major faces running parallel to the planar dimension ([44, 48] and [46, 50]). In one bi-layer (contact layer) of Dufner et al.'s support plate is a mixture of hydrophobic and hydrophilic materials, which creates integrated but discrete regions (column 8, lines 2-8). The other layer (substrate layer) is made of a plurality of hydrophobic [54 A-E, 58 A-E] and hydrophilic [52 A-E 56 A-E] sections, which is shown to alternate across the major planar dimension of the porous plate. It is important to note the connection between hydrophilicity and density of water transfer particles. Dufner et al. teaches that the hydrophilic phase facilitates transfer of liquid (column 4, lines 8-13). Therefore, a high density of water transfer particles corresponds to a hydrophilic nature, while a low density of water transfer particles corresponds to a hydrophobic nature. However, Dufner et al. does not teach a diffusion media where a cross sectional dimension of the relatively high and relatively low particle density regions vary inversely across the diffusion plate or a cross section of the diffusion media in such away that one face is more hydrophobic, while the other is more hydrophilic. Wood, III et al. teaches a multilayer diffusion structure with three layers, an absorption layer, a bulk layer, and a desorption layer with increasing hydrophobicity (column 7, lines 32-41). Figure 3 depicts a diffusion plate against a cathode region. Moreover, the adsorption layer [14] is placed next to the cathode [8], which is said to include an electrocatalyst layer, thus putting the more hydrophilic face (or "first major

face" as denoted by the claim) against a catalyst layer. In Wood, III et al.'s embodiment of a diffusion medium, the first face starts out with a high density of water transfer (hydrophilic) particles, a property that decreases as one moves across the diffusion media. Additionally, Wood, III et al.'s fuel cell puts the hydrophilic side next to the porous cathode electrocatalyst layer [8]. The purpose of this assembly is to disperse reacting gases as well as to remove reaction products (namely water) (column 4, lines 15-19). Because the diffusion plates serve the same purpose, it would have been obvious to one having ordinary skill in the art at the time the invention was made to incorporate this Wood, III et al.'s hydrophobic to hydrophilic relation (in that specific order) to the diffusion plate expressed by Dufner et al.

44. As to claims 43 and 44, the teachings of Dufner et al. and Wood, III et al. are set forth above. None of the prior arts specifically teach relatively high and low particle density regions which vary inversely across a cross section of the porous diffusion media between the first and second major faces of the diffusion media. However, as previously mentioned, a tie between high (water transfer) particle density regions can be aligned with a hydrophilic property. Dufner et al. mentions that the hydrophilic phase used in his contact bi-layer facilitates the transfer of liquid water through the layer (column 4, lines 8-10). Therefore a high density of liquid transfer particles would correlate to having a hydrophilic property. So, Wood, III et al.'s embodiment of a multilayer diffusion structure with an absorption layer, a bulk layer, and a desorption layer with increasing hydrophobicity (column 7, lines 32-41), satisfies the inversely varying high and low particle density regions in the claim. Again, Wood, III et al's fuel

cell puts the hydrophilic side [14] of the diffusion plate next to the porous cathode electrocatalyst layer [8], as seen in figure 3.

45. Regarding claim 45, the teachings of Dufner et al. and Wood, III et al. are set forth above. None of the prior arts specifically teach relatively high and low particle density regions which vary inversely across a cross section of the porous diffusion media so that one side is dominated by a relatively high and the other side is dominated by a relatively low particle density. However, a tie between high (water transfer) particle density regions can be aligned with a hydrophilic property. Dufner et al. mentions that the hydrophilic phase used in his contact bi-layer facilitates the transfer of liquid water through the layer (column 4, lines 8-10). Therefore a high density of liquid transfer particles would correlate to having a hydrophilic property. So, Wood, III et al.'s embodiment of a multilayer diffusion structure with an absorption layer, a bulk layer, and a desorption layer with increasing hydrophobicity (column 7, lines 32-41), satisfies the inversely varying high and low particle density regions on the different faces, as stated in the claim.

46. Regarding claim 48, the teachings of Dufner et al. and Wood, III et al. are set forth above. As previously mentioned, Wood, III et al. teaches a multilayer diffusion structure with an absorption layer, a bulk layer, and a desorption layer with increasing hydrophobicity, (column 7, lines 32-41). The gradient works such that the hydrophobic layer is dispersed on the bulk phase, the more hydrophobic side. Additionally, Dufner et al. teaches that it is known to treat support layers with hydrophobic substances (column 2, lines 52-56). Since the diffusion plates in a fuel cells serves the same purpose, it

would have been obvious to one having ordinary skill in the art at the time the invention was made to put a hydrophobic layer outside the more hydrophobic face of the diffusion plate in order to prevent water from blocking the movement of gases.

47. Regarding claim 49, the teachings of Dufner et al. and Wood, III et al. are set forth above. Wood, III et al. teach a diffusion media against the catalyst layer that includes a membrane electrode assembly (MEA) [3] sandwiched between an anode flow field [12] and a cathode flow field [6], as depicted by figure 2.

48. As to claim 50, the teachings of Dufner et al. and Wood, III et al. are set forth above. Wood, III et al. additionally teaches the use of a the porous diffusion media in combination with a catalyst layer, a MEA, an anode flow field, a cathode flow field in a fuel cell (column 4, lines 54-56). A schematic of the proton exchange membrane fuel cell assembly can be seen in figure 1.

49. As to claim 51, the teachings of Dufner et al. and Wood, III et al. are set forth above. However, it is not taught migrational freedom to allow water transfer particles to traverse to the catalyst layer during fuel cell operation exists. However, it is obvious that if a particle is small enough to fit into the porous diffusion matrix, that it would be small enough to move within that matrix.

50. As to claims 52 and 53, the teachings of Dufner et al. and Wood, III et al. are set forth above. Although none of the prior arts specifically teach their use as a motive source in a vehicle, Wood, III et al. mentions that fuel cells have been proposed for use in electrical vehicular power plants to replace internal combustion engines (column 1, lines 12-15). It would have been obvious to one having ordinary skill in the art at the

time the invention was made to know that fuel cells have the potential to be used as the drive source of a vehicle.

51. Claim 54 is rejected under 35 U.S.C. 03(a) as being unpatentable over Wood, III et al. in view of Dufner et al. and Taniguchi et al.

52. Regarding claim 54, Wood, III et al. teach a membrane electrode assembly (MEA) [3] sandwiched between an anode flow field [12] and a cathode flow field [6], as depicted by figure 2. Wood, III et al. also teach a porous diffusion layer which is positioned against a catalyst layer of the membrane electrode assembly. Column 7, lines 32-41 indicate the porosity of the diffusion plate. Figure 3 depicts the diffusion media [14, 15, 16] placed next to the cathode electrocatalyst layer [8]. Additionally, Wood, III et al.'s plate consists of three layers: and absorption layer, a bulk layer, and a desorption layer, which proceeds with increasing hydrophobicity (column 7, lines 32-41). Wood, III et al. does not specifically teach a porous matrix in which water transfer particles are distributed. Taniguchi et al., however teaches a porous current collector that allows fluid transfer (column 2, lines 52-55). Additionally, Taniguchi et al.'s current collector has hydrophilic material provided to the thin porous substrate (column2, lines 35-42), where the porous matrix can be made of carbon fibers (column 5, lines 56-58). The term "carbon fibers" is taken to include carbon paper, as carbon paper would be constructed of carbon fibers. Suggestions for the hydrophilic material, bulking agent R1, given include carbon black powder (column 7, lines 4-5). Neither teaches a plurality of high and low density regions of water transfer particles. However, Dufner et al. teaches a porous diffusion media that comprises of a plurality of hydrophobic [54A-E; 58

A-E] and hydrophilic [53A-E; 56A-E] regions that repeat in an alternating fashion down the major planar dimension of the diffusion media, as seen in figure 2. Finally, it is necessary to note the connection between hydrophilicity and density of water transfer particles. Dufner et al. teaches that the hydrophilic phase facilitates transfer of liquid (column 4, lines 8-13). Therefore, a high density of water transfer particles corresponds to a hydrophilic nature, while a low density of water transfer particles corresponds to a hydrophobic nature. By combining all 3 sources, hydrophobicity gradient of Wood, III et al.'s porous diffusion media can be induced by using a density gradient of the hydrophilic bulking agent R1 and applied to the hydrophobic regions in the pattern that Dufner et al. specifies. Doing that, a first major face can be defined to be more hydrophilic than the second major face, which is defined to be more hydrophobic. Although none of the previous arts specifically mention the disposition of hydrophobic substance on the second side of the porous diffusion media, Also, as previously mentioned, Wood, III et al. teaches a multilayer diffusion structure with an absorption layer, a bulk layer, and a desorption layer with increasing hydrophobicity, (column 7, lines 32-41). The gradient works such that the hydrophobic layer is dispersed on the bulk phase, the more hydrophobic side. According to Dufner et al., it is known to treat support layers with hydrophobic substances, since it facilitates transport of gaseous reactants, reducing product fluids, while water moves through the support layer as vapor. Additionally, it minimizes the excess accumulation of liquid water at the cathode thereby restricting access to the gaseous oxidant to the cathode electrode (column 2, lines 54-61). Combining the ideas would disperse the hydrophobic material on the hydrophobic side of the diffusion plate. Also polytetrafluoroethylene (PTFE, TEFLON) is taught as something that can be used in hydrophobic regions (column 7, lines 63-68). It would have been obvious to one having ordinary skill in the art at the time the invention was made to combine all of these aspects that make for a good diffusion media in order to optimize its function.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Eugenia Wang whose telephone number is 571-272-4942. The examiner can normally be reached on 8 AM - 4:30 PM Mon. - Thurs., EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on 571-272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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